



**I-84; Echo Frontage Road,
Bridge Replacement Project**

Design Perspective; GRS-IBS

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UDOT Geotechnical Engineer

August 18, 2013

**U.S. Department of Transportation
Federal Highway Administration**
HIGHWAYS FOR LIFE
Accelerating innovation for the American Driving Experience



Presentation Outline

- GRS-IBS Research
- Geotechnical Investigation
- Geotechnical Design
- Instrumentation Program
- Construction Aspects
- Construction Challenges

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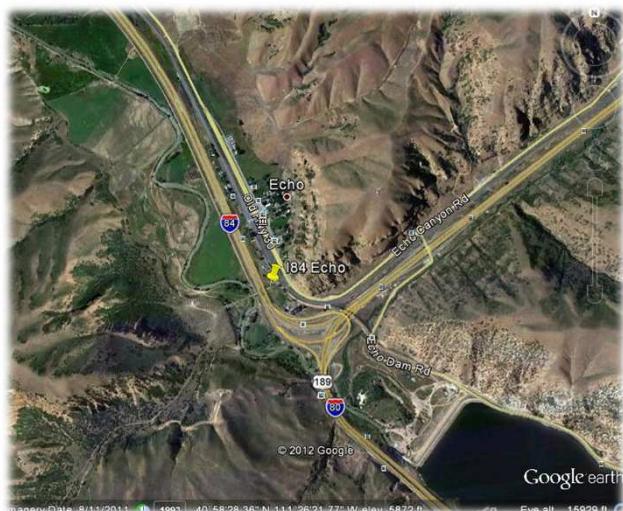
GRS-IBS Research



- NCHRP 12-59 Committee- *Design and Construction Guidelines for Geosynthetic-Reinforced Soil Bridge Abutments with a Flexible Facing* (2006 Green Report 556)
- NCHRP 12-59(01) Committee (Seismic Design of GRS Abutments)- “Jan 2012 Web-only document”, Report 187
- Additional FHWA Research- GRS bents, geotextile spacing and strength, backfill strength, etc.

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Geotechnical Investigation



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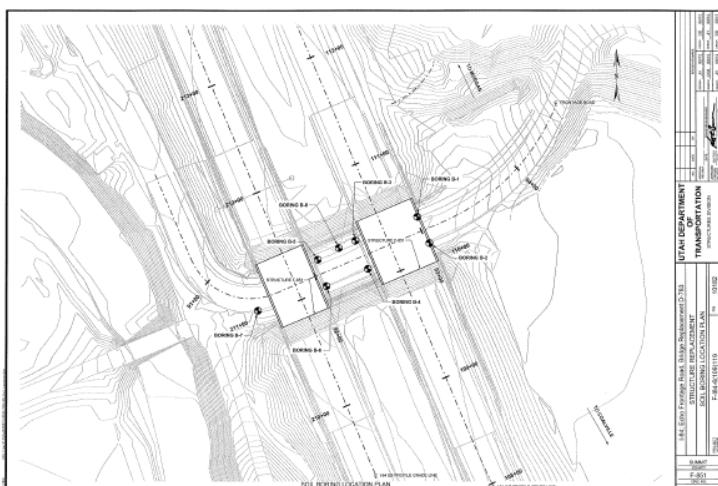
Geotechnical Investigation



ECHO
INNOVATIVE GEOTECHNIQUE

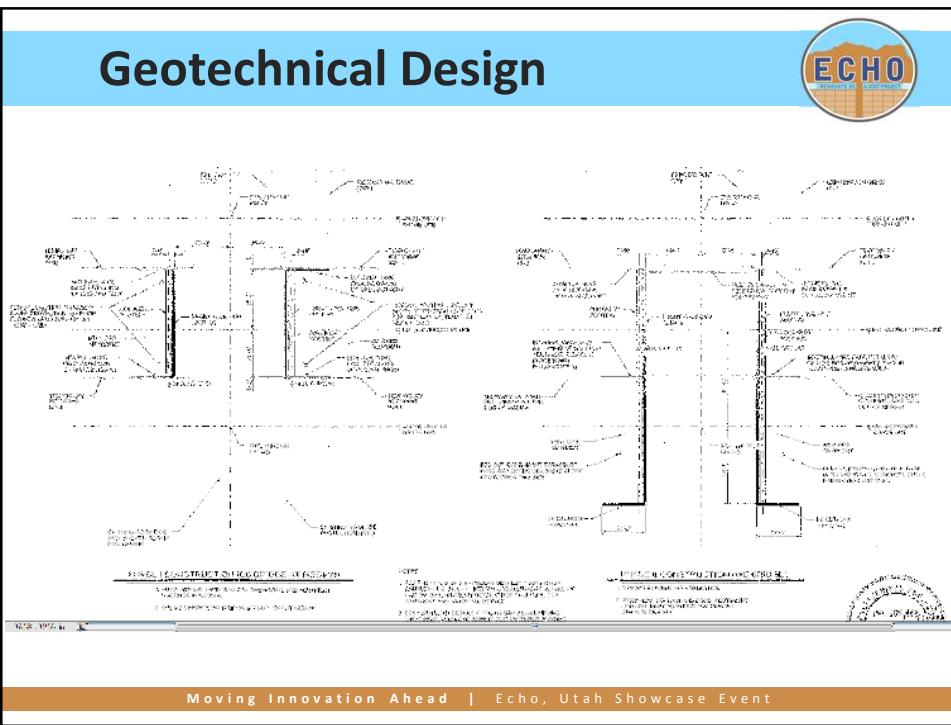
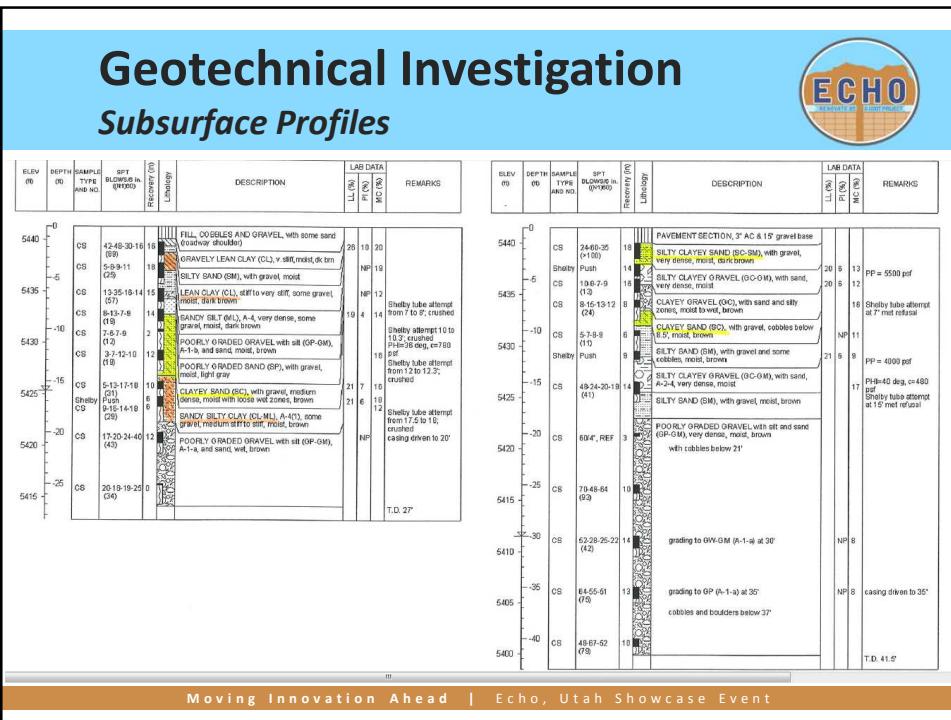
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Geotechnical Investigation
Borehole Locations

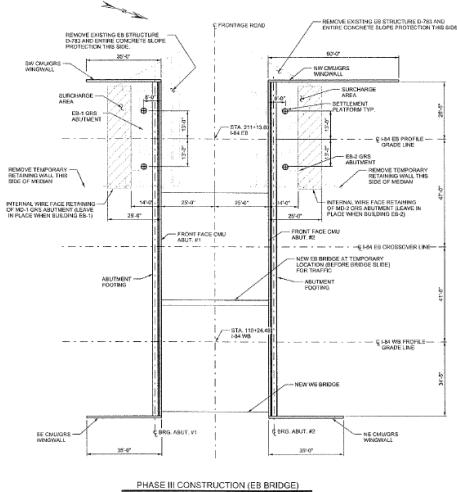


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INNOVATIVE GEOTECHNIQUE

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Geotechnical Design



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Geotechnical Design

Parameters



■ Loading

- Dead load 12,000 lbf
- Live load 7,000 lbf

■ Bearing pressure

- 4,000 psf

■ Seismic

- PHGA = 0.25g
- Spectral-0.2s = 0.61g, 1.0s=0.34g

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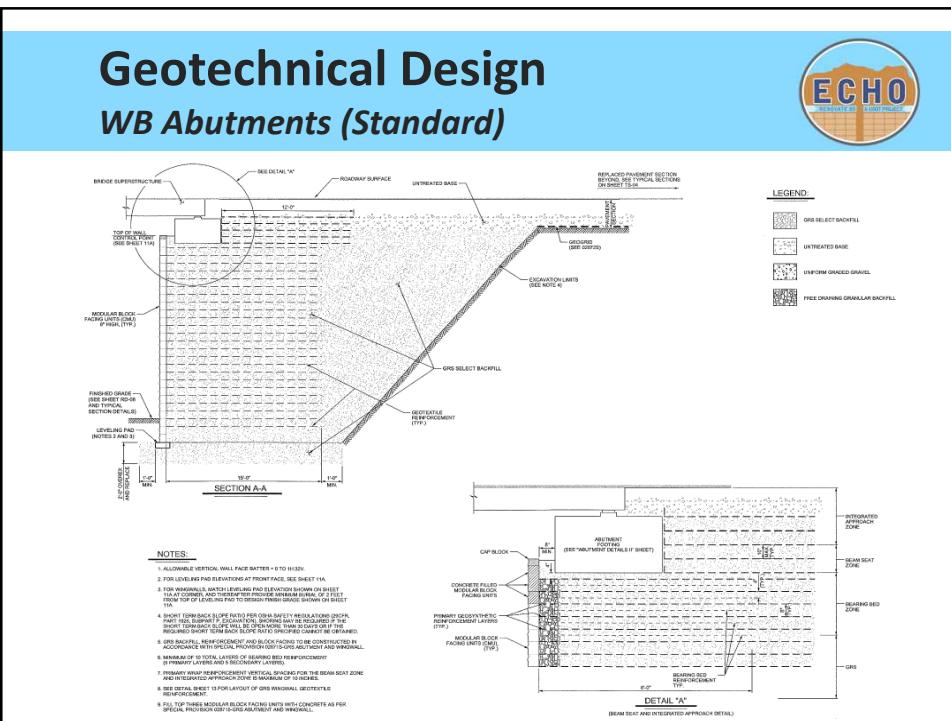


Geotechnical Design Parameters

ECHO
REINFORCED GROUT PRODUCTS

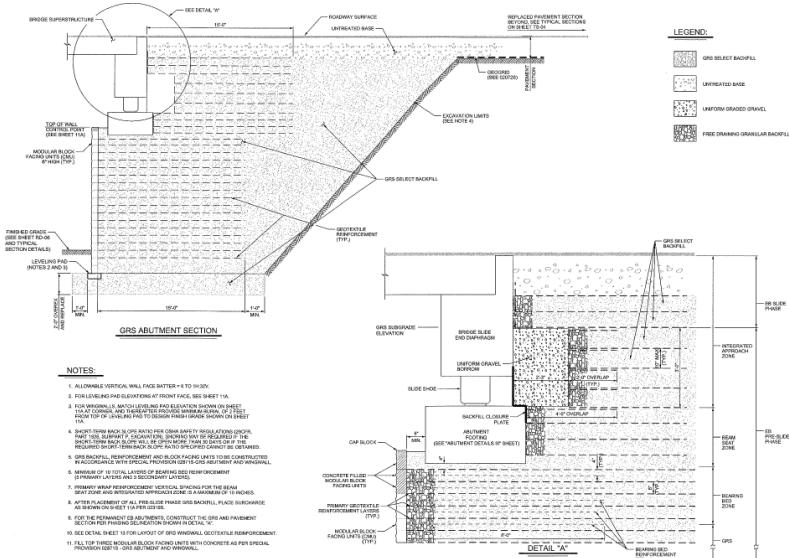
- Geotextile
 - FHWA standard 4800 lbs/ft
 - Woven biaxial polypropylene
- Length
 - $0.8 \times H = 15$ ft
- High-quality GRS backfill
 - 42 degrees

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Geotechnical Design

Median/EB Abutments (Non-standard)



Geotechnical Design

Special Provision



OCTOBER 16, 2012

SPECIAL PROVISION

PROJECT #F-I84-6(109)119

PIN #10182

SECTION 02871S

GRS ABUTMENTS AND WINGWALLS

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Placement requirements and procedures for constructing Geosynthetic-Reinforced Soil (GRS) abutments and wingwalls for bridges.

1.2 RELATED SECTIONS

- A. Section 02056M: Embankment, Borrow, and Backfill
- B. Section 03055: Portland Cement Concrete
- C. Section 03211: Reinforcing Steel and Welded Wire

1.3 REFERENCES

- A. AASHTO T 27: Sieve Analysis of Fine and Coarse Aggregates
- B. AASHTO T 90: Determining the Plastic Limit and Plasticity Index of Soils
- C. AASHTO T 99: Moisture-Density Relations of Soils Using a 2.5-kg (5.5-lb) Rammer and a 305-mm (12 inch) Drop
- D. AASHTO T 104: Soundness of Aggregate by Use of Sodium Sulfate or Magnesium Sulfate
- E. AASHTO T 236: Direct Shear Test of Soils Under Consolidated Drained Conditions
- F. AASHTO T 267: Determination of Organic Content in Soils by Loss on Ignition
- G. AASHTO T 269: Determining pH of Soil for Use in Corrosion Testing



Geotechnical Design
Materials Testing

The banner features a blue header with the title "Geotechnical Design" and "Materials Testing" in black. Below the title is a circular logo for "ECHO" (Earthquake Early Warning) with the tagline "REMOVING RISK FROM YOUR PROJECT". On the left side, there is a vertical strip containing four smaller images showing construction scenes: a bridge under construction, workers on a site, a view of a dam or reservoir, and a highway interchange.

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Geotechnical Design
Wingwalls

The banner features a blue header with the title "Geotechnical Design" and "Wingwalls" in black. Below the title is a circular logo for "ECHO" (Earthquake Early Warning) with the tagline "REMOVING RISK FROM YOUR PROJECT". On the left side, there is a vertical strip containing four smaller images showing construction scenes: a bridge under construction, workers on a site, a view of a dam or reservoir, and a highway interchange.

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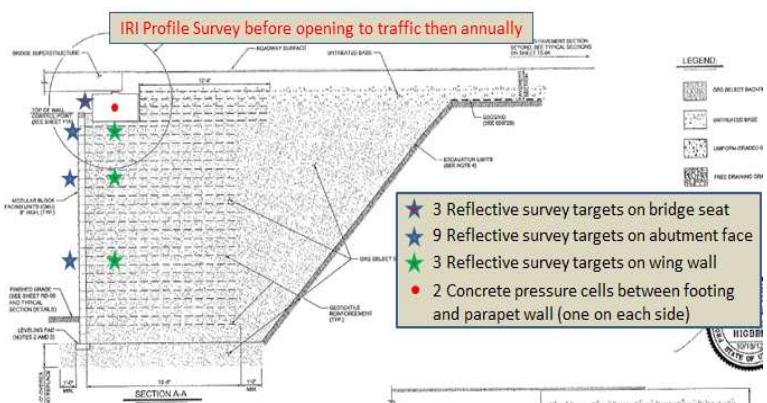
Geotechnical Design



- Construction Phasing
- WB Bridge-Standard GRS design
- Median and EB Bridge- not-so-standard design
- Special Provision Specification
- Materials and Testing
- Placement
- Wingwalls
- Seismic

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Instrumentation Program



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Construction Aspects



- Breaking ground
- Subgrade preparation
- Leveling pads
- Facing block
- Backfill placement (compaction)
- Moisture density testing
- Geotextile reinforcement
- Bearing sill/footing

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Construction Aspects



- Surcharging and settlement monitoring
- Instrumentation program
- Bridge slide
- Construction phasing
- Construction challenges

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Construction Aspects
Breaking Ground

ECHO
MOVING INNOVATION AHEAD

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Construction Aspects
Subgrade Preparation

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Construction Aspects
Leveling Pads

The main image shows a long, narrow concrete foundation or leveling pad being constructed on a dirt site. A worker in an orange vest and blue jeans walks along the top of the pad. The pad has several black leveling jacks protruding from its surface. In the background, there are piles of dirt and some construction equipment. On the left side of the slide, there is a vertical strip containing four smaller images of construction scenes: a bridge under construction, workers on a site, a view of a construction area with mountains in the background, and a view of a bridge under construction from a higher vantage point.

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Construction Aspects
Facing Block

The main image shows a stack of large, rectangular concrete facing blocks wrapped in plastic sheeting. In the foreground, a tray holds several of these blocks, which have a distinctive stepped or ribbed pattern on their top surfaces. On the left side of the slide, there is a vertical strip containing four smaller images of construction scenes: a bridge under construction, workers on a site, a view of a construction area with mountains in the background, and a view of a bridge under construction from a higher vantage point.

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Construction Aspects Facing Block



Anchor Echo Bridge Project Keystn Compli HS Shf Gray
North Salt Lake, UT 04/19/13
Pallet GTY, SE 03
LOT 2 ITEM # 16002000 PCL 16002000

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Construction Aspects Facing Block



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Construction Aspects
Facing Block

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Construction Aspects
Facing Block

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Construction Aspects
Facing Block

The main image shows a worker in an orange vest and white hard hat placing a long, grey concrete facing block onto a foundation. Other workers in safety vests are visible in the background. The ECHO logo is in the top right corner.

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Construction Aspects
Backfill Placement (compaction)

The main image shows two workers using a hand compactor to compact dirt next to a large yellow excavator bucket. The ECHO logo is in the top right corner.

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Construction Aspects
Backfill Placement (compaction)

ECHO
REINVENTING CONSTRUCTION

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The collage on the left includes four smaller images: a close-up of a concrete structure, workers on a site, a view of a bridge under construction, and a view of a bridge deck.

The main image on the right shows a worker in an orange vest and hard hat operating a yellow Volvo SU45i single-drum roller. The worker is using a long metal rod to compact a layer of dark brown soil or aggregate. In the background, there's a large mound of dirt and some yellow safety fencing. The roller has "VOLVO" and "SU45i" printed on its side.

Construction Aspects
Backfill Placement (compaction)

ECHO
REINVENTING CONSTRUCTION

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The collage on the left includes four smaller images: a close-up of a concrete structure, workers on a site, a view of a bridge under construction, and a view of a bridge deck.

The main image on the right shows a worker in an orange vest and hard hat operating a yellow Volvo SU45i single-drum roller. The worker is seated on the roller, which is in contact with a red soil surface. The background shows a large, weathered rock face. The roller has "VOLVO" and "SU45i" printed on its side.



Construction Aspects

Backfill Placement (compaction)



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Construction Aspects

Backfill Placement (compaction)



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Construction Aspects

Backfill Placement (compaction)



The main image shows a yellow Wacker Neuson RT-100 vibratory roller compacting soil at a construction site. The machine has large black tracks and a yellow cab. A small sign on the side of the cab reads "Wacker Neuson RT-100" and "VIBRATORY ROLLER". The background shows a dirt embankment and some construction equipment.

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Construction Aspects

Moisture Density Testing



The main image shows a yellow Wacker Neuson RT-100 vibratory roller compacting soil at a construction site. The machine has large black tracks and a yellow cab. A small sign on the side of the cab reads "Wacker Neuson RT-100" and "VIBRATORY ROLLER". The background shows a dirt embankment and some construction equipment.

- < 95% = 14.9%
- 95-98% = 58.6%
- > 98% = 26.5%

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Construction Aspects

Geotextile Reinforcement



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Construction Aspects

Geotextile Reinforcement



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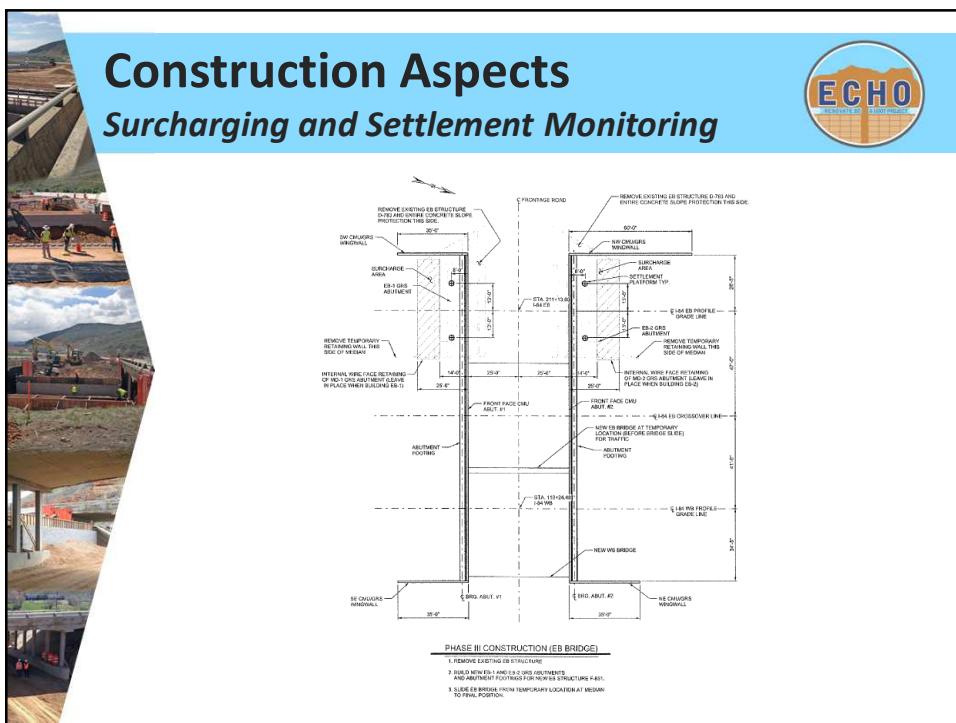


Construction Aspects
Geotextile Reinforcement

The slide features a large central image of a construction worker in an orange vest working on a geotextile reinforcement layer. To the left is a vertical strip containing four smaller construction-related images. In the top right corner is the ECHO logo, which includes a circular graphic of a road and the text "ECHO" above "GEOTECHNIQUE & GROUTING". At the bottom of the slide is a brown banner with the text "Moving Innovation Ahead | Echo, Utah Showcase Event".

Construction Aspects
Geotextile Reinforcement

The slide features a large central image showing a completed geotextile reinforcement layer on a construction site. To the left is a vertical strip containing four smaller construction-related images. In the top right corner is the ECHO logo, which includes a circular graphic of a road and the text "ECHO" above "GEOTECHNIQUE & GROUTING". At the bottom of the slide is a brown banner with the text "Moving Innovation Ahead | Echo, Utah Showcase Event".





Construction Aspects
Surcharging

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Construction Aspects
Surcharging

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Construction Aspects

Surcharging



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Construction Aspects

Surcharging



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Construction Aspects
Settlement Monitoring

The slide features a blue header with the title and a circular logo containing the letters "ECHO" and the text "MOVING INNOVATION AHEAD" below it. In the center is a photograph showing two vertical pipes being measured against a wooden wall. One pipe has markings and a date "6-28-13" written on it. Two measuring tapes are extended from the pipes to a central point, with one tape clearly showing measurements in inches from 0 to 36. The background of the slide shows four smaller construction-related images in a curved arrangement.

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Construction Aspects
Instrumentation Program

The slide features a blue header with the title and a circular logo containing the letters "ECHO" and the text "MOVING INNOVATION AHEAD" below it. In the center is a photograph of a large, stepped concrete retaining wall under construction. Several vertical monitoring instruments or sensors are installed in the wall, with their shadows cast onto the ground in front. The background of the slide shows four smaller construction-related images in a curved arrangement.

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Construction Aspects

Instrumentation Program

Inclinometer - I-84 Echo Utah Bridge - MP 119
North Abutment Wall - WB
Movement Perpendicular to Wall

Distance from top of wall - feet

Cummulative Displacement - Inches
(IPI Baseline - June 18, 2013)

Date	Displacement (Inches)
7/11/2013 3:00	-12
7/23/2013 3:00	-26
7/23/2013 3:00	-28
7/23/2013 3:00	-31
7/23/2013 3:00	-33

Construction Aspects

Instrumentation Program

Construction Aspects

Bridge Slide

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Construction Aspects

Bridge Slide

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MOVING INNOVATION AHEAD

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Construction Aspects
Bridge Slide

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MOVING INNOVATION AHEAD | ECHO, UTAH SHOWCASE EVENT

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Construction Aspects
Bridge Slide

ECHO
MOVING INNOVATION AHEAD | ECHO, UTAH SHOWCASE EVENT

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Construction Aspects
Bridge Slide

The image shows a construction site for a bridge slide. In the foreground, there's a concrete wall and some construction equipment, including a yellow level tool. In the background, a bridge structure is visible against a backdrop of red rock mountains under a clear blue sky.

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ECHO
MOVING INNOVATION AHEAD



Construction Aspects
Bridge Slide

A close-up view of bridge slide components. It shows a concrete pier, a metal track system, and a large concrete beam being lowered or positioned. The scene is set outdoors with a dirt ground and some construction equipment in the background.

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Construction Aspects

Construction Phasing



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Construction Aspects

Construction Phasing



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Construction Aspects

Construction Phasing



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Construction Aspects

Construction Phasing



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Construction Challenges

Under-cutting Leveling Pad



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Construction Challenges

Sloping Wall Face



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